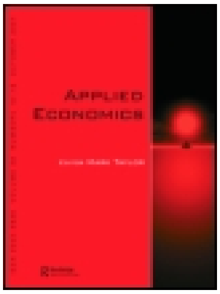

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Household labour supply with rationing in Spain

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This paper provides new empirical evidence on household labour supply with rationing. To that end, we use the latest Spanish data in order to estimate three flexible functional forms, namely the NLES, the quadratic and the Hausman–Ruud forms and calculate the income and wage elasticities. We find that the number of dependants has a negative effect on the labour supply of the female. Moreover, the North and the East Spanish regions have a clearly positive effect on the labour supply of the female, whilst the North has the same effect on that of the male. The elasticities of three functional forms are very similar. Male labour supply is slightly decreasing with the wage, whilst for the female it is increasing. Leisure is a normal good for both spouses, as expected, whilst the labour hours are net substitutes.

I. INTRODUCTION

The success of any national economic policy directed at the labour market depends, essentially, on a detailed knowledge of the economic structure of that market and, particularly, on the effects that wages and income variations have on the labour supply of the agents, that is to say, on a knowledge of wage and income elasticities. In recent years, the theoretical and empirical literature on labour supply has concentrated on analysing the behaviour of married females (Killingsworth and Heckman, 1986) and, secondly, on the male labour supply (Pencavel, 1986). However, few papers have been devoted to an applied analysis of the labour supply of both the male and the female within the family, even though this is the most appropriate context in which to study the effects of income and wage variations. An important point which usually arises in this type of joint analysis is where one spouse does not work, either voluntary or involuntary, implying a real restriction over the behaviour of the other. In this case, which is clearly different from the unrestricted individual analysis, the initial model must be reformulated using the rationing theory, in order to incorporate this specific situation and to obtain the rationed formulation of the labour supply model (e.g. Blundell and Walker, 1982, 1986, with British data; Hausman and Ruud, 1984, Ransom, 1987a, 1987b, with data from the USA; Kooreman and Kapteyn, 1986, Kapteyn *et al*., 1990, and Woittiez, 1991, in the case of the Netherlands; and Phipps, 1990, with Canadian data). In this context, the high unemployment rate (23% in 1996) and the low female participation (37% in 1996) exhibited by the Spanish labour market, coupled with the fact that there is no previous empirical evidence available on joint labour supply in Spain, have been the fundamental reasons that have motivated us to carry out this analysis.

The objective of this paper is to provide new empirical evidence on household labour supply with rationing. To that end, we use data from the most recent Spanish survey which permits us to estimate three flexible functional forms, the comparison of which allows us, in turn, to guarantee that our final results, derived in terms of income and wage elasticities, will be robust. In particular, we consider the NLES proposed by Blundell and Ray (1982), the quadratic utility function and the indirect utility function proposed by Hausman and Ruud (1984), with the NLES being formulated in a context of joint labour supply for the first time. The hypothesis that one of the spouses does not work is then introduced into each model, using the rationing theory which assumes that the employed spouse is restricted with respect to the null labour supply of the other (see Neary and Roberts, 1980; Deaton and Muellbauer, 1981). We specify the three possible labour regimes, namely where both spouses work, or where the male alone works, or where the female alone works. Further, for each flexible form we derive the restricted and unrestricted labour supply functions, from which we obtain the income and Marshallian and Hicksian wage elasticities.

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The paper is organized as follows. In Section II, we explain the household labour supply with rationing. In Section III, we specify the three flexible functional forms of individual preferences, obtaining the expressions of their rationed and unrationed labour supply functions and elasticities. The data and estimation procedure are explained in Section IV. Section V is dedicated to presenting the empirical results and, finally, in Section VI we summarize the most important conclusions of the paper.

II. HOUSEHOLD LABOUR SUPPLY AND RATIONING

The neoclassical household labour supply model considers that the family is formed by two agents who can work, the male and the female, whose objective is to maximize one utility function, the endogenous variables of which are the leisure of both spouses and the total monetary income, $u = u(l_m, l_f, X)$, where l_m is the male leisure time, l_f is the female leisure time and X is the total monetary income. The budget restriction is $Y = \omega_m T + \omega_f T + y = \omega_m l_m + \omega_f l_f + X$, where Y is the full income, ω_m and ω_f are the male and female wages, respectively, T is the time endowment allocated between work and leisure and, finally, y is the nonwage income. This budget restriction implies that the family allocates both the totality of the monetary valuation of its time endowment and the nonwage income, that is to say, the total income available to spend $(\omega_m T + \omega_f T + y)$ on the purchase of both leisure time and consumption goods $(\omega_m l_m + \omega_f l_f + X)$.

However, this model exhibits some limitations derived from the real labour market; for instance, when one spouse does not work because he or she is unemployed or voluntarily chooses not to take part in the labour market. To solve these situations, an approach widely adopted in the empirical literature is to model the labour supply by incorporating rationing. The fundamental results of the rationing theory emanate from various authors (Tobin and Houthakker, 1950–51; Pollak, 1969; Neary and Roberts, 1980), who present a complete analysis of the properties of the demand functions with rationing. These analyses allow us to relate the rationed functions with the unrationed equations, using the virtual price (Rothbarth, 1940–41). One important implication is that rationed family behaviour could be predicted by employing unrationed functions. In this context, Deaton and Muellbauer (1981) explore the rationing theory, with the objective of formulating goods demand functions in the presence of quantity restrictions in the labour market. These functions are fundamental to labour supply analysis in the particular situation cited above, that is to say, the unemployment or non-participation in the labour market of one spouse.

Based on the family labour supply model described above, the cost or expenditure function is:

$$C(\omega_m, \omega_f, u) = \min_{X, l_m, l_f} (\omega_m l_m + \omega_f l_f + X | u(l_m, l_f, X) \geqslant u) \tag{1}$$

that is to say, the minimum monetary valuation of both leisure and income that allows us to obtain the initial utility level u.

If we consider that the labour supply of the female is rationed, that is to say, the leisure demand is $\bar{l}_f$, then the rationed expenditure function will be:

$$C^{R}(\omega_m, \omega_f, u, \bar{l}_f) = \min_{X, l_m} (\omega_m l_m + \omega_f \bar{l}_f + X | u(l_m, \bar{l}_f, X) \geqslant u) \tag{2}$$

where the family only chooses the values of X and l_m that allow it to minimize the monetary valuation of both leisure and income, because the rationed female leisure time, $\bar{l}_f$, is predeterminated.

The following relationship exists between both unrationed and rationed cost functions (see Kooreman and Kapteyn, 1986), namely:

$$C^{R}(\omega_m, \omega_f, u, \bar{l}_f) = C(\omega_m, \bar{\omega}_f^{C}, u) + (\omega_f - \bar{\omega}_f^{C})\bar{l}_f \tag{3}$$

with $\bar{\omega}_f^{C} = \xi(\omega_m, u, y, \bar{l}_f)$ being the female compensated virtual wage, obtained by considering $l_f = \bar{l}_f$ in the compensated or Hicksian demand function for female leisure and solving for ω_f. This virtual wage is the wage that should induce a free choice of $\bar{l}_f$ in the optimum family decision in order to obtain the utility level u.

The rationed Hicksian demand for the male can be obtained by applying Shephard's lemma to Equation 3:

$$\frac{\partial C^{R}(\omega_m, \omega_f, u, \bar{l}_f)}{\partial \omega_m} = \frac{\partial C(\omega_m, \bar{\omega}_f^{C}, u)}{\partial \omega_m} + \frac{\partial C(\omega_m, \bar{\omega}_f^{C}, u)}{\partial \bar{\omega}_f^{C}} \frac{\partial \bar{\omega}_f^{C}}{\partial \omega_m} - \bar{l}_f \frac{\partial \bar{\omega}_f^{C}}{\partial \omega_m} = \frac{\partial C(\omega_m, \bar{\omega}_f^{C}, u)}{\partial \omega_m} \tag{4}$$

that is to say, the rationed compensated demand for the male is equal to the unrationed Hicksian demand when the wage of the female is her virtual wage, $l_m^{RC}(\omega_m, \omega_f, u, \bar{l}_f) = l_m^{C}(\omega_m, \bar{\omega}_f^{C}, u)$.

Thereafter, following Neary and Roberts (1980) and Deaton and Muellbauer (1981), the restricted uncompensated or Marshallian demand for the male is derived by substituting the noncompensated virtual wage in the unrestricted function and adding the saving that is obtained to the full income:

$$l_m^{R}(\omega_m, \omega_f, Y, \bar{l}_f) = l_m[\omega_m, \bar{\omega}_f, Y + (\bar{\omega}_f - \omega_f)\bar{l}_f] \tag{5}$$

where $\bar{\omega}_f = \varphi(\omega_m, \omega_f, Y, \bar{l}_f)$ is the uncompensated virtual wage of the female which must satisfy $\bar{l}_f = l_f[\omega_m, \bar{\omega}_f, Y + (\bar{\omega}_f - \omega_f)\bar{l}_f]$ and which gives rise to $\bar{l}_f$ as the optimum leisure time after solving the utility maximization problem.

In the families where both spouses work, the resolution of the utility maximization problem allows us to derive the Marshallian labour supply functions for both spouses in terms of the leisure demands:

$$h_i(\omega_m, \omega_f, Y) = T - l_i(\omega_m, \omega_f, Y) \quad i = m,f \tag{6}$$

whereas, if the female does not work, we consider the restricted system where $\bar{l}_f = T$, that is to say:

$$h_m(\omega_m\, \bar{\omega}_f, \bar{Y}) = T - l_m(\omega_m, \bar{\omega}_f, \bar{Y}) \tag{7a}$$

$$h_f(\omega_m, \bar{\omega}_f, \bar{Y}) = T - l_m(\omega_f, \bar{\omega}_f, \bar{Y}) = 0 \tag{7b}$$

where $\bar{Y} = \omega_m T + \bar{\omega}_f T + y$. If the restriction is not effective, that is to say, if the female optimum solution is to choose zero worked hours, then her virtual wage will be the real wage that the labour market supplies to her. By contrast, if the restriction is effective, then the virtual and the real wage do not coincide, with the first being higher than the second. By analogy, the same is the case if it is the male who chooses not to work.

Moreover, the resolution of the dual optimization problem, that is to say, the minimization of the expenditure in order to obtain a predeterminated utility level, allows us to derive the Hicksian labour supply functions:

$$h_i^C(\omega_m, \omega_f, u) = T - l_i^C(\omega_m, \omega_f, u) \qquad i = m,f \tag{8}$$

and, if the female does not work, we have:

$$h_m^C(\omega_m, \bar{\omega}_f^C, u) = T - l_m^C(\omega_m, \bar{\omega}_f^C, u) \tag{9a}$$

$$h_f^C(\omega_m, \bar{\omega}_f^C, u) = T - l_f^C(\omega_m, \bar{\omega}_f^C, u) = 0 \tag{9b}$$

Finally, Appendix A contains the general expressions of the income elasticities and of the Marshallian and Hicksian wage elasticities, all of them derived from the uncompensated and compensated labour supply functions Equations 6, 7a, 7b, 8, 9a and 9b.

III. FLEXIBLE FUNCTIONAL FORMS

The choice of the most appropriate functional form in which to carry out our analysis is not an easy one. However, according to Stern (1984), there are some appropriate properties which the chosen labour supply model must present; in particular, consistency with the economic theory, simplicity of the theory calculus and of the empirical estimation and, finally, flexibility. With the objective of guaranteeing that our final results will be robust, in this paper we have chosen three functional forms which satisfy all these properties; that is to say, they make it easy to both derive the expressions of elasticities and to estimate with a particular data set. For each of these functional forms we first obtain specific results and then present the common results that appear in all three forms by way of final conclusions.

Let us now turn to the expressions of the three functional forms we have chosen, namely the NLES formulation, the quadratic utility function and the Hausman–Ruud indirect utility function. The main difference among the three flexible forms is the relative complexity of their expressions, with the third being the simplest and the second being the most complex. We present the first functional form in great detail because, as mentioned earlier, this specification has only been estimated for demand functions and thus has not been used in a labour supply context, neither in the unrestricted form, nor when considering the theoretical implications of the rationing theory. With respect to the other two utility functions, our presentation is much briefer, with the reader being able to find the complete expressions for the quadratic formulation in Ransom (1987a) and for the third flexible functional form in Hausman and Ruud (1984).

The NLES functional form

The NLES functional form is a generalization of the Linear Expenditure System (Stone, 1954; Blundell and Ray, 1982) which permits nonseparable preferences. In a context of joint labour supply, and considering the total monetary income as an aggregated consumption good whose price is equal to one, the NLES form with linear Engel curves is obtained from the following cost function:

$$C(\omega_m, \omega_f, u) = a(\omega_m, \omega_f) + b(\omega_m, \omega_f)u \tag{10}$$

where

$$\begin{aligned} a(\omega_m, \omega_f) = {} & \gamma^*_{ff}\, \omega_f + \gamma^*_{fm}\omega_f^{1/2}\, \omega_m^{1/2} + \gamma^*_{fq}\omega_f^{1/2} \\ & + \gamma^*_{mf}\, \omega_m^{1/2}\, \omega_f^{1/2} + \gamma^*_{mm}\omega_m + \gamma^*_{mq}\omega_m^{1/2} \\ & + \gamma^*_{qq} + \gamma^*_{qf}\, \omega_f^{1/2} + \gamma^*_{qm}\omega_m^{1/2} \end{aligned} \tag{11a}$$

$$b(\omega_m, \omega_f) = \omega_f^{\beta f}\, \omega_m^{\beta m} \tag{11b}$$

with β_i and γ^*_{ij} being parameters.

From the expenditure function 10 with 11a and 11b, we derive the corresponding indirect utility function. Thereafter, by applying Roy's lemma, we derive the demand functions of leisure, from which we directly obtain the supply functions of labour relative to the male and the female:

$$\begin{aligned} h_i = {} & \bar{\gamma}_{ii} - \gamma_{ij}\left(\frac{\omega_j}{\omega_i}\right)^{1/2} - \gamma_{iq}\left(\frac{1}{\omega_i}\right)^{1/2} \\ & - \frac{\beta_i}{\omega_i}(y + \bar{\gamma}_{ff}\, \omega_f - 2\gamma_{fm}\omega_m^{1/2}\, \omega_f^{1/2} - 2\gamma_{fq}\omega_f^{1/2} \\ & + \gamma_{mm}\omega_m - 2\gamma_{mq}\omega_m^{1/2} - \gamma_{qq}) \\ & i, j = m,f \qquad i \neq j \end{aligned} \tag{12}$$

where $\gamma_{ij} = (\gamma^*_{ij} + \gamma^*_{ji})/2$ and $\bar{\gamma}_{ii} = T - \gamma_{ii}$, $i = m,f$. The theoretical hypotheses are formulated in terms of the parameters of the model, namely adding-up: $\sum_i \beta_i = 1, i = m, f, q$; and symmetry: $\gamma_{ij} = \gamma_{ji}$, $i, j = m,f, q$.

The Hicksian labour supply system, which we will use in the calculus of the compensated wage elasticities, is derived by applying Shephard's lemma to the cost function 10:

$$h_i^{\mathrm{C}} = \bar{\gamma}_{ii} - \gamma_{ij}\left(\frac{\omega_j}{\omega_i}\right)^{1/2} - \gamma_{iq}\left(\frac{1}{\omega_i}\right)^{1/2} - \beta_i u \omega_j^{\beta_j} \omega_i^{\beta_i - 1}$$

$$i, j = m, f \qquad i \neq j \tag{13}$$

The labour supply system Equations 12 and 13 correspond to a situation where restrictions on the labour hours that agents wish to supply do not exist. However, if such agents are in fact restricted in this way, then it is evident that the original theoretical specification must include this new characteristic in its formulation.

In this paper, we consider that the labour supply of one spouse is rationed. In particular, we assume that this spouse does not work and, hence, its labour supply is null, which implies a restriction that affects the labour supply of the other.

As we stated in expression 5, the rationing theory allows us to obtain the Marshallian functions of the rationed agents from the functions of the unrationed ones, substituting the current wage by the virtual wage and adding the difference between both wages, multiplied by the rationed quantity, in our case T, to the total income. If we assume that it is the female who does not work, then the rationed Marshallian labour supply of the male will be:

$$h_m^{\mathrm{R}} = \bar{\gamma}_{mm} - \gamma_{fm}\left(\frac{\bar{\omega}_f}{\omega_m}\right)^{1/2} - \gamma_{mq}\left(\frac{1}{\omega_m}\right)^{1/2}$$

$$- \frac{\beta_m}{\omega_m}(y + \bar{\gamma}_{ff}\,\bar{\omega}_f - 2\gamma_{fm}\omega_m^{1/2}\,\bar{\omega}_f^{1/2} - 2\gamma_{fq}\bar{\omega}_f^{1/2}$$

$$+ \bar{\gamma}_{mm}\omega_m - 2\gamma_{mq}\omega_m^{1/2} - \gamma_{qq}) \tag{14}$$

and the female virtual wage is obtained solving ω_f from expression 12 equal to zero, that is to

$$\bar{\omega}_f = \left[\frac{-(2\beta_f - 1)(\gamma_{fm}\omega_m^{1/2} + \gamma_{fq}) \pm (2\beta_f - 1)^2(\gamma_{fm}\omega_m^{1/2} + \gamma_{fq})^2 + 4\beta_f(1 - \beta_f)\bar{\gamma}_{ff}(y + \bar{\gamma}_{mm}\omega_m - \gamma_{qq} - 2\gamma_{mq}\omega_m^{1/2})]^{1/2}}{2\bar{\gamma}_{ff}(1 - \beta_f)}\right]^2 \tag{15}$$

Moreover, when it is the female who does not work, the Hicksian labour supply of the male will be obtained directly from Equation 13, substituting ω_f by $\bar{\omega}_f^{\mathrm{C}}$:

$$h_m^{\mathrm{RC}} = \bar{\gamma}_{mm} - \gamma_{fm}\left(\frac{\bar{\omega}_f^{\mathrm{C}}}{\omega_m}\right)^{1/2} - \gamma_{mq}\left(\frac{1}{\omega_m}\right)^{1/2} - \beta_m u \bar{\omega}_f^{\mathrm{C}\beta_f} \omega_m^{\beta_m - 1} \tag{16}$$

where $\bar{\omega}_f^{\mathrm{C}}$ is obtained from h_m^{RC} equal to zero.

An analogous procedure will apply if it is the male who is unemployed or chooses not to take part in the labour market.

From both the general expressions of the elasticities contained in Table A1 and functions 12, 13, 14 and 16, we can easily derive the particular expressions of the income and wage affects.

The quadratic utility function

The quadratic specification has been widely used in labour supply analysis (Brown *et al.*, 1976; Wales and Woodland, 1983; Ransom, 1978a, 1978b; Lacroix and Fortin, 1992) because it allows us to obtain the virtual wages in their explicit form in those models which incorporate rationing. The general form of the quadratic utility function is:

$$u(x) = \alpha' x + \frac{1}{2} x' \beta x \tag{17}$$

where

$$x' = (l_m, l_f, X),\ \alpha' = (\alpha_m, \alpha_f, \alpha_q) \text{ and } \beta = \begin{pmatrix} \beta_{mm} & \beta_{mf} & \beta_{mq} \\ \beta_{mf} & \beta_{ff} & \beta_{fq} \\ \beta_{mq} & \beta_{fq} & \beta_{qq} \end{pmatrix}$$

with α_i and β_{ij} $(i, j = m, f, q)$ being parameters.

By maximizing the utility function 17 subject to the corresponding budget restriction, we can derive the Marshallian demand functions of leisure and income, from which we obtain the labour supply functions. Moreover, by solving the dual optimization problem we obtain the Hicksian labour supply functions. We then apply the rationing theory in order to derive the restricted functions and, finally, the general expressions contained in Table A1 allow us to obtain income and wage elasticities of this functional form.

The Hausman–Ruud indirect utility function

Hausman and Ruud (1984) have proposed an indirect utility function that has been used in some household labour supply analyses with rationing (Fortin and Bernier, 1988; Kapteyn *et al.*, 1990; Kapteyn and Woittiez, 1990; Woittiez, 1991), that is to say:

$$v(\omega, y) = \exp(\beta'\omega)(y + \theta + \delta'\omega + \tfrac{1}{2}\omega' A \omega) \tag{18}$$

where

$$\beta' = (\beta_m, \beta_f),\ \delta' = (\delta_m, \delta_f),\ A = \begin{pmatrix} \gamma_m & \alpha \\ \alpha & \gamma_f \end{pmatrix}$$

and θ are parameters, and $\omega' = (\omega_m, \omega_f)$.

By applying Roy's lemma to the indirect utility function 18, we derive the uncompensated labour supply functions. Moreover, the Hicksian labour supplies will be obtained by applying Shephard's lemma to the cost function that we can easily derive from function 18. As in the case of the other two functional forms, we apply the rationing theory and can thus obtain the income and wage elasticities by using the general expressions contained in Table A1.

IV. DATA AND ESTIMATION METHOD

Data

In this paper we employ one Spanish cross-section corresponding to 1991 in order to estimate the three functional forms. The statistical information is obtained from the survey *Encuesta de Estructura*, *Conciencia y Biografía de Clase* (*ECBC*) which includes 1454 feasible observations. In Appendix B we include a detailed explanation of the subsample selection procedure, as well as the definition, mean and standard deviation of all variables, and the composition sample.

Estimation method

In order to derive the estimated wage of the males and females who do not work, we follow the Heckman (1979) method, which solves the bias problem that results from estimating the wages using only the workers. If the labour supply is $h_i = x_i' \gamma_i + u_i$, where x_i is a vector of exogenous variables, γ_i are parameters and u_i is the error term, the agent will work if $h_i > 0$ and will not work if $h_i \leqslant 0$. The first stage of the Heckman procedure is the estimation of a probit model, where $I_i = 1$ if $h_i > 0$ and $I_i = 0$ if $h_i \leqslant 0$:

$$p_{\gamma}(h_i = 1) = \Phi(a_0 + \sum_{j=1}^{k} a_j z_{ji}) \qquad i = 1, \ldots, n \tag{19}$$

where a_0 and a_j are parameters and z_j are exogenous variables. The second stage implies the inclusion of λ, the inverse of the Mills ratio, $\lambda = \phi(Z'_{\gamma})/[1 - \Phi(Z'_{\gamma})]$, where $\phi(\cdot)$ and $\Phi(\cdot)$ are the density and distribution functions, respectively, of a typified normal. When λ is introduced into the wage equation, consideration is being given to the fact that we are only observing the wage of workers. Thereafter, λ is an indicator of the effect on the sample wages from the nonobservation of the wages of nonworkers. Hence, the inclusion of λ allows us to consistently estimate the wage equation:

$$\omega_i = b_0 + \sum_{j=1}^{m} b_j x_{ji} + b_i \lambda + \varepsilon_i \tag{20}$$

where b_0 and b_j are parameters, x_{ji} are the exogenous variables and b_i is the covariance between the error terms of the wage and employment equations.

We estimate one probit model of participation for males and another for females, incorporating as explicative variables the age, the age raised to square and divided by 100, education levels, family size, net nonwage income and housing areas. We have included housing area variables because there are clear differences in its labour market characteristics, that is to say, the unemployment rates, the female participation rates and the hours worked. In particular, the *Encuesta de Población Activa* published by the Instituto Nacional de Estadística shows that the Northern Spanish regions exhibit lower values of unemployment, and higher values of female participation and hours worked than do the Centre and Southern regions.

The results are set out in Table 1. For males, the significant variables are both the age variables, education levels, household size and the North, East, Madrid and Islands areas, with all of them having a positive parameter, except age raised to square. For females, education levels and the North, East, Madrid and Islands areas are also significant and positive, whilst age, age raised to square and nonwage income are significant and negative. This indicates that age increases the probability of work for males and decreases it for females, with the effect corresponding to males being less than proportional, because the parameter of age raised to square has the opposite sign than that of age. Education has a positive effect on participation, with those males with secondary education and those females with university education showing the highest participation levels. Household size has a positive effect for males, increasing the probability of work as the number of dependants increases. Moreover, nonwage income has a clear negative effect on the probability that females work. Finally, all significant housing area variables exhibit a higher probability for the Centre.

The results of the wage equation estimation also appear in Table 1. For males, age, education levels and the Madrid area are significant and positive, whilst age raised to square and the Islands are negative. As regards females, age and education levels are also significant and positive, with age raised to square being negative. Thus, we can note that there are no very important differences between males and females, with wages increasing with age and education levels in both cases. Wage differences among regions are only significant for males. The wage is higher in Madrid and lower in the Islands, all with respect to the Centre. Finally, λ is not significant in any equation, indicating that there is no bias problem in the sample selection.

In the neoclassical labour supply model, with the rationing specified above, we can distinguish three different regimes. In the first, I_1, both spouses work. In the second, I_2, only the male works, and in the third, I_3, only the female works. The functional form of the labour supply is different in each regime, resulting in the following switching endogenous model, in its stochastic form (see Kooreman and Kapteyn, 1986):

$$h_m^* = h_m(\omega_m, \omega_f, y) + \varepsilon_m$$
$$h_f^* = h_f(\omega_m, \omega_f, y) + \varepsilon_f$$
$$\left.\begin{array}{l} h_m = h_m^* \\ h_f = h_f^* \end{array}\right\} \text{if } h_m^* > 0 \text{ and } h_f^* > 0. \text{ Reg. } I_1 \tag{21}$$
$$\left.\begin{array}{l} h_m^R = h_m(\omega_m, \bar{\omega}_f, y) + \varepsilon_m^R \\ h_f = 0 \end{array}\right\} \text{if } h_f^* \leqslant 0. \text{ Reg. } I_2$$
$$\left.\begin{array}{l} h_m = 0 \\ h_f^R = h_f(\bar{\omega}_m, \omega_f, y) + \varepsilon_f^R \end{array}\right\} \text{if } h_m^* \leqslant 0. \text{ Reg. } I_3$$

Table 1. *Estimation of participation and wage equations*

Participation equations			Wage equations		
Endogenous variable: 1 = works; 0 = does not work			Endogenous variable: net wage per hour		
	Male	Female		Male	Female
CONSTANT	0.678*	0.599*	*CONSTANT*	421.288*	228.625
	(2.21)	(2.74)		(4.02)	(1.52)
AGE	0.023*	− 0.043*	*AGE*	8.312*	14.051*
	(2.71)	(− 3.21)		(2.56)	(4.02)
$AGE^2/100$	− 0.043*	− 0.069*	$AGE^2/100$	− 4.023*	− 2.652*
	(− 1.97)	(− 2.05)		(− 2.18)	(− 1.96)
EDUCATION2	0.632*	0.198*	*EDUCATION2*	151.212*	202.365*
	(2.32)	(2.43)		(3.33)	(2.86)
EDUCATION3	0.312*	0.745*	*EDUCATION3*	350.289*	315.852*
	(2.50)	(8.12)		(11.45)	(4.05)
HSIZE	0.077**	− 0.025	*NORTH*	167.159	36.125
	(1.89)	(− 0.34)		(1.02)	(1.33)
y	$-0.11\ 10^{-7}$	$-0.32\ 10^{-6}$*	*EAST*	101.159	102.125
	(− 0.23)	(− 1.97)		(1.12)	(1.02)
NORTH	0.431*	0.431*	*MADRID*	107.298*	68.723
	(2.01)	(4.21)		(3.02)	(1.44)
EAST	0.421*	0.987*	*ISLANDS*	− 60.545**	− 26.551
	(1.99)	(7.04)		(− 1.88)	(− 1.24)
MADRID	0.321**	0.635*	*SOUTH*	− 44.653	− 80.654
	(1.90)	(5.34)		(− 0.98)	(− 1.19)
ISLANDS	0.789*	0.315*	λ *HECKMAN*	− 452.158	35.164
	(2.02)	(2.96)		(− 0.22)	(1.10)
SOUTH	0.098	0.201	Observations	1388	953
	(0.41)	(1.53)			
Observations	1454	1454	R^2	0.28	0.44

Note: *t*-statistics in parentheses. * Significant at the 5% level. ** Significant at the 10% level.

We have introduced the error terms assuming that there are no differences among the preferences of households with the same characteristics. Moreover, these error terms $(\varepsilon_m, \varepsilon_f, \varepsilon_m^R, \varepsilon_f^R)'$ follow a multivariant normal distribution, with a covariance matrix:

$$\Sigma = \begin{pmatrix} \sigma_m^2 & \cdot & \cdot & \cdot \\ \sigma_{fm} & \sigma_f^2 & \cdot & \cdot \\ * & \sigma_{mfR} & \sigma_{mR}^2 & \cdot \\ \sigma_{fmR} & * & * & \sigma_{fR}^2 \end{pmatrix} \tag{22}$$

where * indicates that these terms do not appear in the likelihood function. Moreover, due to the low number of nonworking males, we impose $\sigma_{mR}^2 = \sigma_{fR}^2 = \sigma_R^2$ and $\sigma_{fmR} = \sigma_{mfR}$ in the estimation.

Model 21 is estimated in its budget share form, with the likelihood function being:

$$L = \prod_{i \in I_1} f_1(s_f^{*i}, \mathbf{s}_m^{*i}) \prod_{i \in I_2} \int_{-\infty}^{0} f_2(s_f^i, s_m^{Ri}) \times \mathrm{d}s_f^i \prod_{i \in I_3} \int_{-\infty}^{0} f_3(s_m^i, s_f^{Ri})\, \mathrm{d}s_m^i \tag{23}$$

where s_f^*, s_m^*, s_m^R and s_f^R are the income shares of h_f^*, h_m^*, h_m^R and h_f^R, respectively, f_1 is the joint density function of s_f^{*i} and s_m^{*i}, f_2 is the joint density function of s_f^i and s_m^{Ri}, and f_3 is the joint density function of s_m^i and s_f^{Ri}.

Let us now introduce the family socioeconomic characteristics in the parameters of every model. The parameters of the NLES form, into which we introduce housing area variables, family size and the presence of dependants of different ages, are β_f, β_m, $\bar{\gamma}_{ff}$ and $\bar{\gamma}_{mm}$. The parameters β_f and β_m are defined in terms of household size $\beta_f = \beta_{ff} - \beta_{fm} \ln(HSIZE)$ and $\beta_m = \beta_{mm} + \beta_{fm} \ln(HSIZE)$, with the adding-up condition $\beta_f + \beta_m + \beta_q = 1$. On the other hand, the parameters $\bar{\gamma}_{ff}$ and $\bar{\gamma}_{mm}$ allow for the translation effect (see Pollak and Wales, 1978) and depend on a constant and on different variables which indicate household composition and housing area:

$$\bar{\gamma}_{jj} = \gamma_j + \gamma_{jh}\ln(HSIZE) + \gamma_{j1} N1 + \gamma_{j2} N2 + \gamma_{j3} N3 + \gamma_{j4} N4 + \gamma_{j5} N5 + \gamma_{jn} NORTH + \gamma_{je} EAST + \gamma_{jma} MADRID + \gamma_{ji} ISLANDS + \gamma_{js} SOUTH \qquad j = m, f \tag{24}$$

Table 2. *Estimated parameters of the NLES functional form*

		Male ($j = m$)		Female ($j = f$)
Elements of $\bar{\gamma}_{jj}$				
Intercept	γ_j	4.146*		57.321*
		(27.78)		(94.88)
HSIZE	γ_{jh}	−0.421*		−5.145*
		(−4.16)		(−12.52)
*N*1	γ_{j1}	0.312*		−3.523*
		(4.25)		(−12.25)
*N*2	γ_{j2}	0.182*		−4.292*
		(3.26)		(−40.72)
*N*3	γ_{j3}	0.326*		−4.325*
		(2.21)		(−20.45)
*N*4	γ_{j4}	0.458*		−3.693*
		(3.81)		(−26.45)
*N*5	γ_{j5}	0.220		−3.782*
		(1.31)		(−14.27)
NORTH	γ_{jn}	1.090*		1.742*
		(13.10)		(23.32)
EAST	γ_{je}	1.230*		2.188*
		(15.44)		(9.10)
MADRID	γ_{jma}	1.329*		2.665*
		(14.52)		(9.84)
ISLANDS	γ_{ji}	−0.994*		−1.821*
		(−7.38)		(−10.31)
SOUTH	γ_{js}	−0.451*		−2.252*
		(−5.21)		(−19.10)
Utility function constants	γ_{jq}	0.782*		15.314*
		(10.10)		(164.60)
	γ_{fm}		−14.592*	
			(−79.21)	
	γ_{qq}		2.145	
			(−)	
Elements of β_{jj}				
Intercept	β_{jj}	0.021*		0.810*
		(5.02)		(233.41)
HSIZE	β_{fm}		−0.032*	
			(−11.36)	
Variances/covariances	σ_j	0.025*		0.032*
		(182.85)		(144.39)
	σ_{fm}		$0.24\ 10^{-3}$*	
			(34.04)	
	σ_R		0.031*	
			(82.52)	
	σ_{fmR}		$0.16\ 10^{-3}$*	
			(9.42)	
Log likelihood	1861.2			

Note: *t*-statistics in parentheses. * Significant at the 5% level.

In the other two formulations, the sociodemographic variables are introduced in the parameters in the same way as in the NLES functional form, taking the α_j coefficients for the quadratic form and the δ_j parameters in the Hausman and Ruud functional form.

We have also introduced some restrictions in the estimation of the three functional forms. First, we have imposed the following restriction in the NLES formulation in order to avoid the presence of numerical errors. $(2\beta_i - 1)^2(\gamma_{ij}\omega_j^{1/2} + \gamma_{iq})^2 + 4\beta_i(1-\beta_i)\bar{\gamma}_{ii}(y + \bar{\gamma}_{jj}\omega_j - \gamma_{qq} - 2\gamma_{jq}\omega_j^{1/2}) \geqslant 0,\ i, j = m, f,.\ i \neq j.$ Secondly, we have normalized the parameters in the quadratic utility function: $\beta_{mm} + \beta_{ff} + \beta_{qq} = 1$, and thirdly, we have imposed the concavity hypothesis in the Hausman–Ruud indirect utility function: $\theta \leqslant -(y + \omega_i h_i + \omega_j h_j + \frac{1}{2}\gamma_j\omega_j^2)\frac{1}{2}\gamma_i^{-1}(\delta_i - h_i +$

Table 3. *Estimated elasticities of the NLES functional form*

	Both spouses work		Only the male works		Only the female works	
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Male Marshallian own-wage elasticity: E_{mm}	−0.043	0.184	−0.204	0.244		
Female Marshallian own-wage elast.: E_{ff}	0.182	0.580			0.032	0.686
Male non-labour income elasticity: E_m	−0.005	0.027	−0.015	0.066		
Female non-labour income elasticity: E_f	−0.075	0.447			−0.030	0.142
Male Hicksian own-wage elasticity: E^C_{ff}	0.390	0.183	0.567	0.491		
Female Hicksian own-wage elasticity: E^C_{mm}	0.488	0.582			0.930	0.693
Male Marshallian cross-wage elasticity: E_{mf}	−0.267	0.135				
Female Marshallian cross-wage elast.: E_{fm}	−0.432	0.527				
Male Hicksian cross-wage elasticity: E^C_{mf}	−0.316	0.141				
Female Hicksian cross-wage elasticity: E^C_{fm}	−0.527	0.540				

$\alpha\omega_j)^2 - \frac{1}{2}\gamma_i^{-1}\beta_i^2(\beta' A^{-1}\beta)^{-2} + (\beta' A^{-1}\beta)^{-1}, i, j = m, f, i \neq j$ (Kapteyn *et al.*, 1990).

Finally, the monetary variables are expressed in thousands of pesetas, whilst the time period is, as usual, the annual hours divided by 100, with the available hours/day taken at 16.

V. EMPIRICAL RESULTS

We shall now consider the empirical results obtained from the estimation of the three functional forms, presenting the common results as robust conclusions. The estimated parameters of the NLES functional form appear in Table 2. As can be seen, all the coefficients are significant at the 5% level, except γ_{m5}. With respect to the significant parameters corresponding to $\bar{\gamma}_{mm}$, we can observe that household size has a negative effect on male labour supply, whilst dependants' dummies have a positive effect. Moreover, the North, the East and Madrid coefficients are significant and positive, whilst those of the Islands and the South are significant and negative. With respect to the parameters corresponding to $\bar{\gamma}_{ff}$, we can note that household size, as well as dependants of every age, have a negative effect on female labour supply. As regards the geographical variables, female labour supply in the North, the East and in Madrid is higher than in the Centre, the reference area, whilst that corresponding to the Island and the South is lower. Finally, the parameters $\gamma_{mq}, \gamma_{fq}, \gamma_{fm}, \beta_{mm}, \beta_{ff}, \beta_{fm}$, the variances and the covariances are also significant at the conventional 5% level.

In Table 3 we indicate the mean and the standard deviation of the income and wage elasticities in the three possible situations. When both spouses work, the own-wage Marshallian elasticity of the male and the cross-wage elasticities of the male and the female are negative, with the former being very small, whilst the own-wage Marshallian effect of the female is positive. Hence, male labour supply is close to constant, whilst corresponding to the female is increasing, with both reducing their labour supply when the wage of the other increases. The nonwage income elasticities are negative for both the male and the female, as expected, with the highest corresponding to the latter. If only the male works, then the income and Marshallian elasticities are negative, whereas the Hicksian is positive. Finally, if only the female works, then both wage elasticities are positive, whereas the income effect is negative.

The estimation results of the quadratic form appear in Table 4. We can observe that the majority of parameters are significant at the 5% level. The parameters α_m and α_f have positive signs. Moreover, α_m falls when family size increases, and α_f increases with family size and dependants. These are expected signs, because an increasing α_j implies a decrease in the labour supply of spouse j, as we can easily prove from the labour supply functions. With respect to the housing area variables, we can observe that the male significant parameters are positive for the North, the Islands and the South and negative for Madrid, whereas the North, the East, Madrid and the Islands have a positive effect on female labour supply and the South has a negative one.

Table 5 shows the elasticities. The Marshallian own-wage effect for the male is negative and small, whereas the elasticity for the female is positive. The income elasticities are negative and very close to zero. The Hicksian own-wage effects are positive, whilst the Marshallian and Hicksian cross-wage are negative. Therefore, we can deduce that both workers are net substitutes.

In Table 6 we set out the estimated parameters of the Hausman–Ruud functional form. We can observe that the majority of coefficients are significant at the 5% level. We can deduce that family size and dependants have a positive effect on the labour supply of the male and a negative one on that of the female. With respect to the housing area dummies, the North and Islands have a positive and negative sign, respectively, for both spouses. The effects of the

Table 4. *Estimated parameters of quadratic functional form*

		Male ($j = m$)		Female ($j = f$)
Elements of α_j				
Intercept	α_{jj}	12.353*		32.202*
		(7.12)		(18.96)
HSIZE	α_{jh}	−0.371*		0.391*
		(−7.33)		(2.02)
*N*1	α_{j1}	−0.019		0.414*
		(−0.62)		(2.21)
*N*2	α_{j2}	0.013		0.323*
		(0.51)		(2.68)
*N*3	α_{j3}	−0.595*		1.475*
		(−6.62)		(9.17)
*N*4	α_{j4}	−0.631*		0.882*
		(−8.62)		(4.10)
*N*5	α_{j5}	0.071		3.434*
		(0.37)		(13.88)
NORTH	α_{jn}	−0.589*		−1.951*
		(−5.22)		(−12.29)
EAST	α_{je}	−0.157		−3.810*
		(−0.84)		(−18.51)
MADRID	α_{jma}	0.444**		−4.681*
		(1.83)		(−7.09)
ISLANDS	α_{ji}	−0.610*		−2.597*
		(−4.01)		(−9.67)
SOUTH	α_{js}	−0.170*		0.312*
		(−7.16)		(2.02)
Utility function constants	α_q		0.023	
			(0.15)	
	β_{jj}	0.310*		0.671*
		(13.18)		(25.62)
	β_{jq}	0.012*		0.004
		(5.10)		(1.40)
	β_q		0.019	
			(–)	
	β_{fm}		0.001	
			(0.06)	
Variances/covariances	σ_j	0.029*		0.072*
		(181.02)		(153.36)
	σ_{fm}		$-0.11\ 10^{-3}$*	
			(−4.40)	
	σ_R		0.003*	
			(2.37)	
	σ_{fmR}		$0.31\ 10^{-3}$*	
			(15.10)	
Log likelihood	1942.0			

Note: *t*-statistics in parentheses. * Significant at the 5% level. ** Significant at the 10% level.

East and the South are negative for the male and positive for the female, with the reverse being the case for Madrid.

The mean and standard deviation of the elasticities appear in Table 7. The Marshallian own-wage effect for the male is negative and small, being almost null if he alone works, whilst the same effect for the female is positive. The income effects are almost zero. The Hicksian own-wage elasticities are positive and the cross-wage effects are negative and very low. We can also note the low value of all elasticities, with the labour supply of the female being the highest when there is a wage change.

Finally, we compare the outcomes obtained from the three functional forms. The common results show that an increase in family size decreases the female labour supply. Moreover, the existence of dependants with ages of between 10 and 18 increases the male supply. An analysis of the housing area dummies allows us to conclude that the labour supply is higher in the North for the male, and in the North and the East for the female, in both cases with respect to the Centre. The elasticities show that the own-wage effects for the male are negative and very small, whereas those corresponding to the female are positive. The income elasticities

Table 5. *Estimated elasticities of the quadratic functional form*

	Both spouses work		Only the male works		Only the female works	
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Male Marshallian own-wage elasticity: E_{mm}	−0.055	0.224	−0.190	0.426		
Female Marshallian own-wage elasticity: E_{ff}	0.075	0.162			0.071	0.117
Male non-labour income elasticity: E_m	$-0.5\ 10^{-3}$	0.005	$-0.6\ 10^{-5}$	0.003		
Female non-labour income elasticity: E_f	$-0.9\ 10^{-3}$	0.021			$-0.5\ 10^{-4}$	$0.4\ 10^{-3}$
Male Hicksian own-wage elasticity: E^C_{ff}	0.039	0.093	0.141	0.537		
Female Hicksian own-wage elasticity: E^C_{mm}	0.062	0.149			0.013	0.067
Male Marshallian cross-wage elasticity: E_{mf}	−0.010	0.050				
Female Marshallian cross-wage elasticity: E_{fm}	−0.233	0.130				
Male Hicksian cross-wage elasticity: E^C_{mf}	$-0.4\ 10^{-3}$	0.037				
Female Hicksian cross-wage elasticity: E^C_{fm}	−0.218	0.125				

Table 6. *Estimated parameters of the Hausman–Ruud functional form*

		Male ($j = m$)		Female ($j = f$)
Elements of δ_j				
Intercept	δ_{jj}	31.241*		36.362*
		(149.15)		(177.81)
HSIZE	δ_{jh}	1.962*		−12.141*
		(24.28)		(−123.11)
N1	δ_{j1}	1.879*		−1.510*
		(44.21)		(−22.52)
N2	δ_{j2}	1.333*		−1.198*
		(43.01)		(−23.02)
N3	δ_{j3}	1.100*		−2.151*
		(13.41)		(18.24)
N4	δ_{j4}	0.436*		−1.632*
		(7.89)		(−13.85)
N5	δ_{j5}	0.851*		−2.133*
		(10.42)		(−14.62)
NORTH	δ_{jn}	2.985*		0.285*
		(50.14)		(3.45)
EAST	δ_{je}	−1.132*		1.520*
		(−21.87)		(24.31)
MADRID	δ_{jma}	0.263*		−0.122**
		(4.85)		(−1.84)
ISLANDS	δ_{ji}	−5.019*		−4.102*
		(−49.20)		(−34.65)
SOUTH	δ_{js}	−0.311*		0.708*
		(−5.19)		(13.06)
Utility function constants	γ_j	4.719*		5.818*
		(298.85)		(217.19)
	β_j	−0.185*		−0.073*
		(−110.38)		(−75.15)
	α		−0.181*	
			(−7.62)	
	θ		20.821	
			(–)	
Variances/covariances	σ_j	0.018*		0.091*
		(234.52)		(180.51)
	σ_{fm}		$0.19\ 32^{-3}$*	
			(6.55)	
	σ_R		0.037*	
			(193.21)	
	σ_{fmR}		−0.015	
			(−0.25)	
Log likelihood	2837.6			

Note: *t*-statistics in parentheses. * Significant at the 5% level. ** Significant at the 10% level.

Table 7. *Estimated elasticities of the Hausman–Ruud functional form*

	Both spouses work		Only the male works		Only the female works	
	Mean	St.dev.	Mean	St.dev.	Mean	St.dev.
Male Marshallian own-wage elasticity: E_{mm}	−0.115	0.210	−0.018	0.894		
Female Marshallian own-wage elasticity: E_{ff}	0.177	0.229			0.287	0.345
Male non-labour income elasticity: E_m	−0.007	0.026	0.016	0.089		
Female non-labour income elasticity: E_f	−0.004	0.011			−0.073	0.163
Male Hicksian own-wage elasticity: E^C_{ff}	0.022	0.159	0.088	0.223		
Female Hicksian own-wage elasticity: E^C_{mm}	0.227	0.252			0.704	0.634
Male Marshallian cross-wage elasticity: E_{mf}	−0.183	0.191				
Female Marshallian cross-wage elasticity: E_{fm}	−0.135	0.152				
Male Hicksian cross-wage elasticity: E^C_{mf}	−0.065	0.157				
Female Hicksian cross-wage elasticity: E^C_{fm}	−0.078	0.122				

are very low, close to zero. The Hicksian own-price effects show different average values in the three functional forms; however, in every model the effect is positive and higher for the female than for the male. Finally, the Marshallian and Hicksian cross-wage elasticities are negative.

We can conclude that our results are in accordance with those of other analyses of Spanish female labour supply. In particular, Hernández and Riboud (1985), Fernández (1985), García *et al.* (1989) and Martínez-Granado (1994) have obtained Marshallian wage effects for the female of between 0.10 and 0.29, similar to our own.

VI. CONCLUSIONS

In this paper we have provided new empirical evidence on household labour supply with rationing, using the most recent Spanish survey data in order to carry out this applied analysis. In particular, we have derived the income and wage elasticities from three flexible functional forms, namely the NLES, the quadratic utility function and the Hausman–Ruud indirect utility function. Further, into each form we have introduced the hypothesis that one of the two spouses does not work, using the rationing theory which assumes that the employed spouse is restricted with respect to the null labour supply of the other. We have specified three different labour regimes, namely where both spouses work, where the male alone works and where the female alone works. With respect to each flexible form, we have derived the restricted and unrestricted labour supply functions, from which we have in turn derived the income and Marshallian and Hicksian wage elasticities.

The majority of results are similar and, therefore, we can select the simplest form, that is to say, the Hausman–Ruud formulation, in order to model the household labour supply with rationing in Spain. In all three flexible forms, family size and the composition of the household appear as important variables in the labour supply of the female. As the number of dependants increases, so the labour supply of the female decreases. In all age groups, the presence of dependants has a negative effect on the labour supply of the female, but this effect is lower than that corresponding to family size. With respect to the geographical variables, the North and the East have a clearly positive effect on the labour supply of the female, whilst the North has a positive effect on that of the male, in both cases with respect to the Centre. These effects are in accordance with the higher employment and female participation levels which these housing variables show with respect to the reference area.

The elasticities of the three models show that if both spouses work, then the own-wage effects for the male are negative and very small, whereas those corresponding to the female are positive, lower than 0.2, but higher than for the male. If only the female works, the own-wage effects are lower than 0.3. The average of the income elasticities are very low, close to zero. The Hicksian own-price effects show different average values in the three functional forms, but in every model the effect is positive and higher for the female than for the male. Finally, the Marshallian and Hicksian cross-wage elasticities are negative. In summary, the male labour supply is decreasing and almost a constant, whereas that of the female is simply increasing. Leisure is a normal good for both spouses, as expected, whilst the labour hours are net substitutes. Therefore, the impact of any economic policy that modifies wages will be higher for female labour supply than for male.

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APPENDIX A

In Table A1 we show the general expressions of income and wage elasticities, both with and without restrictions. If there are no restrictions, the expressions are derived from the unrationed labour supply functions, whereas the restricted expressions are presented considering that the female does not work. All specific formulas corresponding to the three flexible functional forms are available upon request.

Table A1. *Income and wage general elasticities*

	Without restrictions		With restrictions
Income	$E_i = \dfrac{\partial h_i(\omega_m, \omega_f, y)}{\partial y}\dfrac{y}{h_i}$	$i = m, f$	$E_m = \left(\dfrac{\partial h_m(\omega_m, \bar{\omega}_f, y)}{\partial y}\Bigg\vert_{\bar{\omega}_f} + \dfrac{\partial h_m(\omega_m, \bar{\omega}_f, y)}{\partial \bar{\omega}_f}\dfrac{\partial \bar{\omega}_f}{\partial y} \right)\dfrac{y}{h_m}$
Wage Marshallian	$E_{ij} = \dfrac{\partial h_i(\omega_m, \omega_f, y)}{\partial \omega_j}\dfrac{\omega_j}{h_i}$	$i, j = m, f$	$E_{mm} = \left(\dfrac{\partial h_m(\omega_m, \bar{\omega}_f, y)}{\partial \omega_m}\Bigg\vert_{\bar{\omega}_f} + \dfrac{\partial h_m(\omega_m, \bar{\omega}_f, y)}{\partial \bar{\omega}_f}\dfrac{\partial \bar{\omega}_f}{\partial \omega_m} \right)\dfrac{\omega_m}{h_m}$
Wage Hicksian	$E^C_{ij} = \dfrac{\partial h^C_i(\omega_m, \omega_f, y)}{\partial \omega_j}\dfrac{\omega_j}{h_i}$	$i, j = m, f$	$E^C_{mm} = \left(\dfrac{\partial h^C_m(\omega_m, \bar{\omega}_f, u)}{\partial \omega_m}\Bigg\vert_{\bar{\omega}^C_f} + \dfrac{\partial h^C_m(\omega_m, \bar{\omega}_f, u)}{\partial \bar{\omega}^C_f}\dfrac{\partial \bar{\omega}^C_f}{\partial \omega_m} \right)\dfrac{\omega_m}{h^C_m}$

APPENDIX B

Table B1 summarizes the way in which the final subsample used in this paper has been obtained. First, we have eliminated 7 observations due to computer mistakes. Thereafter, we have chosen families made up of both spouses and, secondly, of both spouses and single dependants, thereby obtaining 5612 observations. If survey was answered by just one spouse (and not by other family members) in order to obtain information about the other spouse, then 3836 observations remain. Moreover, if we remove families where one spouse works, and the other also works, or is dedicated to housework or is unemployed, then the sample is reduced to 3020. The wage earning workers include 2092 observations. If we require that the dependants be students under 24 years of age, the subsample totals 1655. Thereafter, we have eliminated the observations where some fundamental information is lacking, thereby obtaining 1454 final observations, all of which include solely both spouses and dependants.

In addition to the above procedure, we have used weights to solve the equiprobability problem of the *ECBC* which results from two overrepresentations, namely the agents with secondary and university education levels and, secondly, the agents from the Madrid housing area.

Once the number of final observations has been calculated, the following stage is to specify the variables. Table B2

Table B1. *Subsample selection procedure*

Selection criteria	Observations remaining in sample
Total observations	6632
1 Without computer mistakes	6625
2 Families made up of both spouses or of both spouses and single dependants	5612
3 Survey answered by one of the spouses	3836
4 One spouse works and the other also works, or is dedicated to housework or is unemployed	3020
5 The workers are wage earners	2092
6 The dependants are students and under 24 years of age	1655
7 Full information	1454

Table B2. *Definition, mean and standard deviation of variables*

Definition		Mean	St.dev.
AGEM	Male age	39.24	8.79
AGEF	Female age	36.73	8.88
*EDM*1	Male primary education level	0.58	0.49
*EDM*2	Male seconary education level	0.20	0.40
*EDM*3	Male university education level	0.22	0.41
*EDF*1	Female primary education level	0.66	0.47
*EDF*2	Female secondary education level	0.17	0.38
*EDF*3	Female university education level	0.17	0.37
ω_m^*	Male net wage per hour (in pesetas)	782.50	510.71
ω_f^*	Female net wage per hour (in pesetas)	708.77	855.12
h_m^*	Male weekly working hours	40.70	7.78
h_f^*	Female weekly working hours	39.45	10.47
y	Net non-wage income of the household per year (in pesetas)	56 247.36	240 315.37
HSIZE	Household size	3.61	1.01
*N*1	Dependants (aged 0–4 years)	0.15	0.36
*N*2	Dependants (aged 5–9 years)	0.36	0.48
*N*3	Dependants (aged 10–14 years)	0.17	0.38
*N*4	Dependants (aged 15–18 years)	0.16	0.37
*N*5	Dependants (aged 19–23 years)	0.25	0.43
NORTH	Housing area: Asturias, Cantabria, Navarra, Galicia, País Vasco and La Rioja	0.21	0.40
EAST	Housing area: Aragón, Cataluña and Valencia	0.32	0.47
CENTRE	Housing area: Castilla-La Mancha, Castilla León and Extremadura	0.12	0.33
MADRID	Housing area: Madrid	0.10	0.30
ISLANDS	Housing area: Baleares and Canarias	0.06	0.23
SOUTH	Housing area: Andalucía and Murcia	0.20	0.40

Note: * Only for those working.

Table B3. *Final sample composition*

	Males		
Females	Working	Not working	Total
Working	887	66	953
Not working	501	0	501
Total	1388	66	1454

presents the definition, the average and the standard deviation of all the variables. The calculation of these is easy, save for the net wage and the net nonwage income, where problems arise due to the different tax treatment given to each individual. We consider three education dummy variables: primary, secondary and university.

In the estimation of each labour supply functional form, we must consider the sample distribution of workers and nonworkers. In Table B3 we present the detailed composition of the sample as between males and females. Note that 953 out of 1454 females work. With respect to the males, 1388 work and the rest, 66, do not.